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Optimization of hydraulic fracturing design in unconventional formation: comparative of study of fracking fluids

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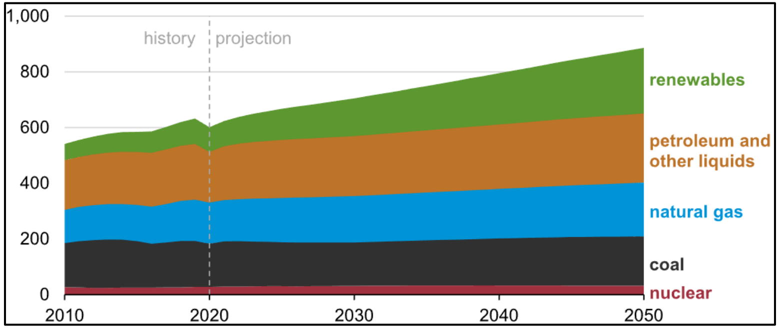
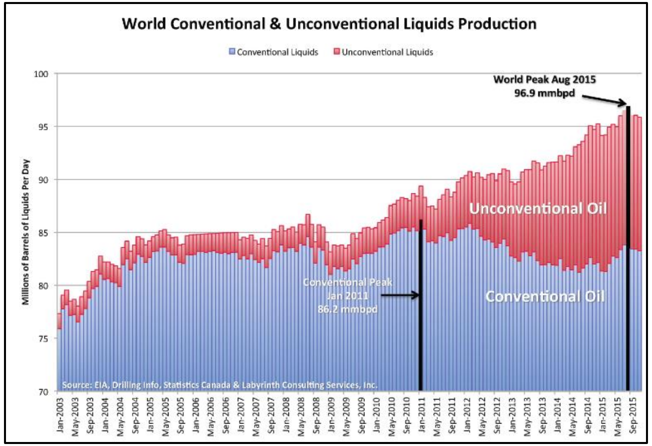
Contents

Motivation

- Oil & gas are still predicted to be dominant source of energy in 2050 (EIA)
- Unconventional sources play a significant role in oil & gas production (EIA)
- Horizontal drilling & hydraulic fracturing made unconventional sources economically viable
- **Production from unconventional sources is non optimal due to reservoir heterogeneity & fracturing design flaws**



Credit: EIA



Credit: EIA, Drilling info

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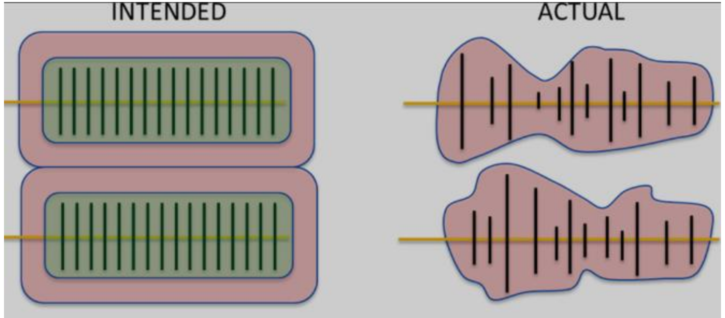
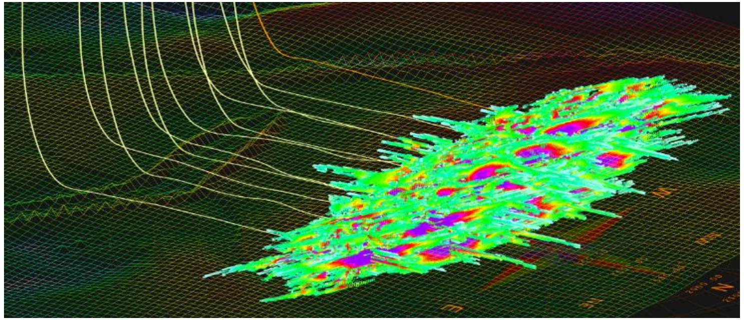
Literature review

- **Hydraulic fracturing optimization** is a big and still active research area
- Combination of **field, experimental and numerical simulation** studies are used to study and optimize hydraulic fracking (King GE, 2010)
- **Numerical simulation study** is the most used technique in the literature (Adachi J et al., 2007; He Q et al., 2016; Murdoch LC, 2002)
- Studies focused on **various aspects of fracking optimization**: well position, number of HFs, spacing, half-length, treatment design etc (Holt, 2011; Wilson and Durlofsky, 2013; Ma et al., 2015; Plaksina and Gildin, 2015)



Credit: JM Lynk et al., 2017



Credit: Halliburton

Workflow overview

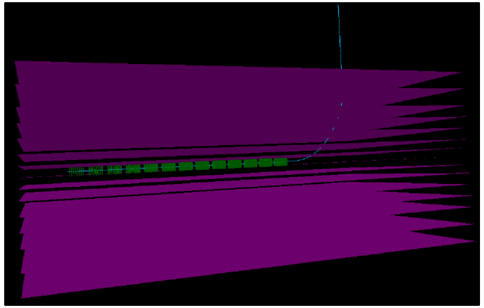
Structural modeling

Facies and properties modeling

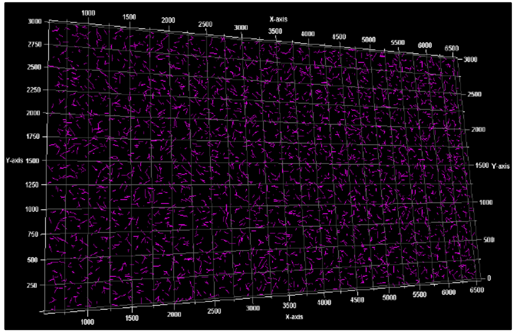
Discrete fracture network modeling

Well modeling

Multistage hydraulic fracturing simulation



Reservoir architecture, layers and well



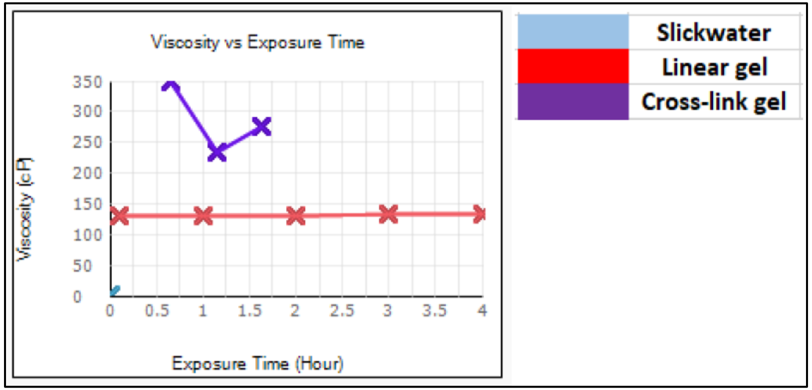
Natural fracture distribution in the field

	Step name	Pump rate (bbl/min)	Fluid name	Fluid volume (gal)	Proppant	Prop. conc (PPA)
1	Pad	20.00	YF125-Flex - M...	10000.00	None	0.00
2	Pad	20.00	YF125-Flex - M...	10000.00	None	0.00
3	Pad	20.00	YF125-Flex - M...	10000.00	None	0.00
4	0.5 PPA	20.00	YF125-Flex - M...	10000.00	Badger Sand 20/40	0.50
5	0.75 P...	20.00	YF125-Flex - M...	10000.00	Badger Sand 20/40	0.75
6	1 PPA	20.00	YF125-Flex - M...	10000.00	Badger Sand 20/40	1.00
7	1.5 PPA	20.00	YF125-Flex - M...	10000.00	Badger Sand 20/40	1.50
8	2 PPA	20.00	YF125-Flex - M...	10000.00	Badger Sand 20/40	2.00
9	2.5 PPA	20.00	YF125-Flex - M...	10000.00	Badger Sand 20/40	2.50
10	3 PPA	20.00	YF125-Flex - M...	10000.00	Badger Sand 20/40	3.00
11	3.5 PPA	20.00	YF125-Flex - M...	10000.00	Badger Sand 20/40	3.50
12	4 PPA	20.00	YF125-Flex - M...	10000.00	Badger Sand 20/40	4.00
13	4.5 PPA	20.00	YF125-Flex - M...	10000.00	Badger Sand 20/40	4.50
14	5 PPA	20.00	YF125-Flex - M...	10000.00	Badger Sand 20/40	5.00

Pump schedule for all stages

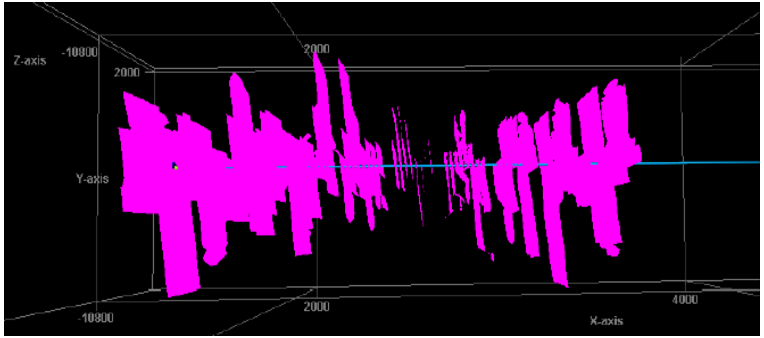
Optimization problem overview

- The performances of 3 different fracking fluids are compared in this study: slickwater, linear and cross-link gel
- Performance metrics are 1) fracture length 2) propped fracture area 3) total fracture area
- Fracking fluids differ among each other mainly by the viscosity values
- Cross link gel has their highest viscosity values, followed by linear gel and slickwater

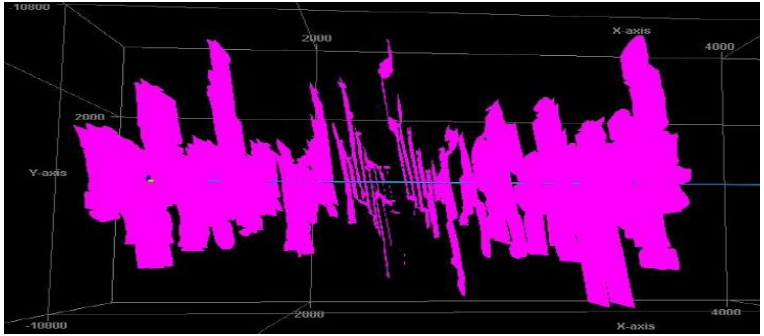


Viscosity evolution through time for 3 fracking fluids

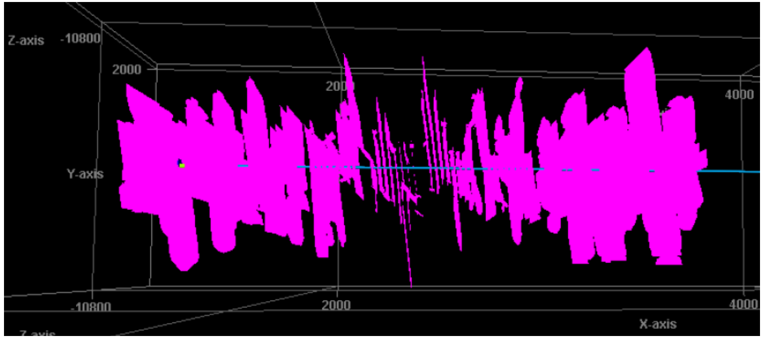
Results 1: Fracture distributions



Fracture distribution for case 1



Fracture distribution for case 3



Fracture distribution for case 2

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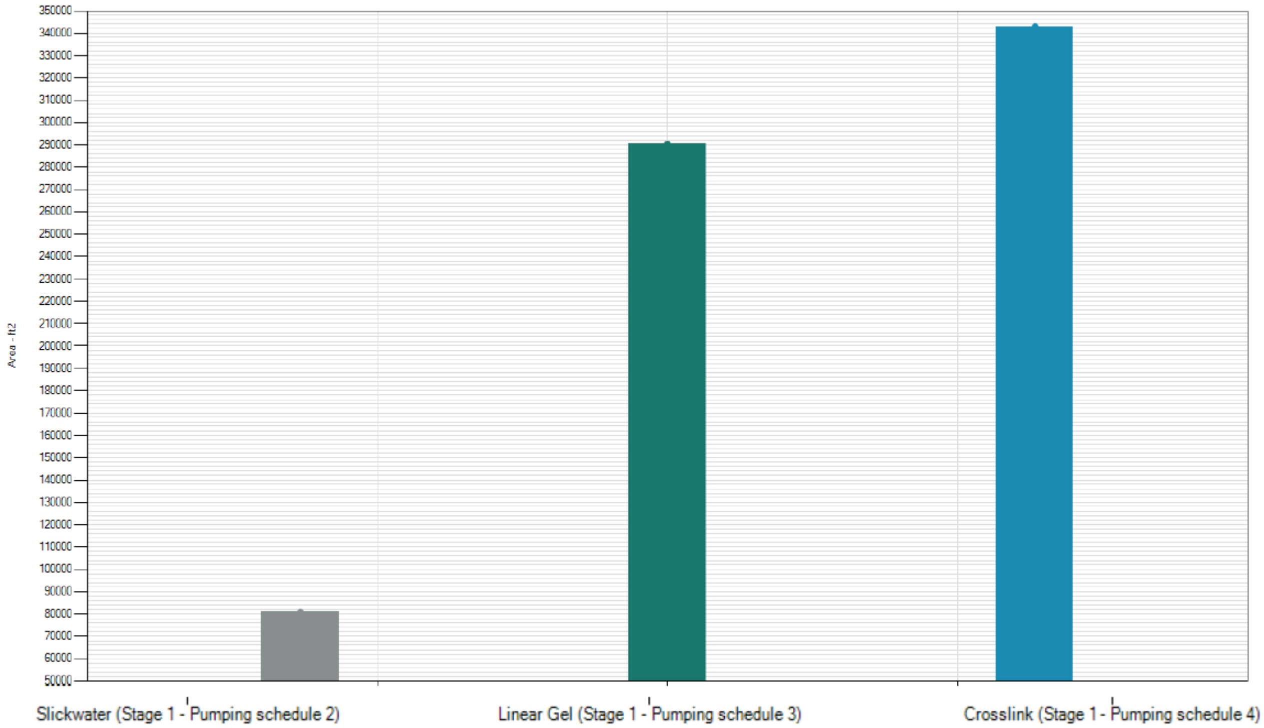
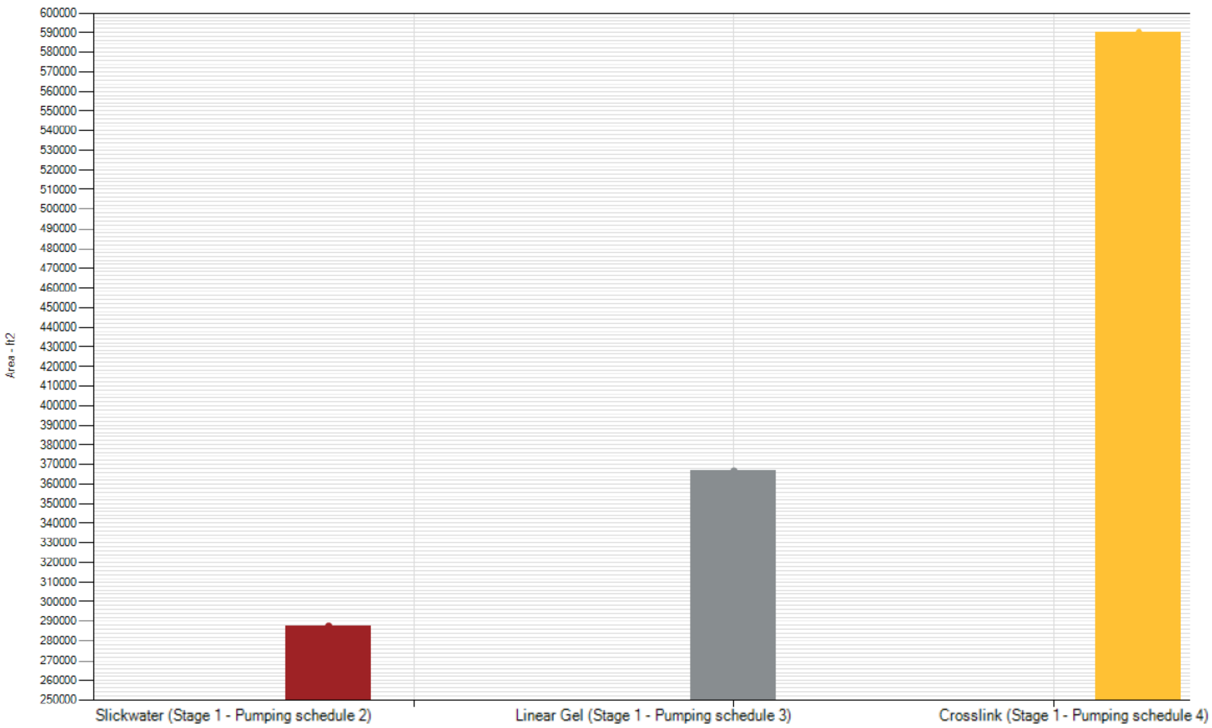
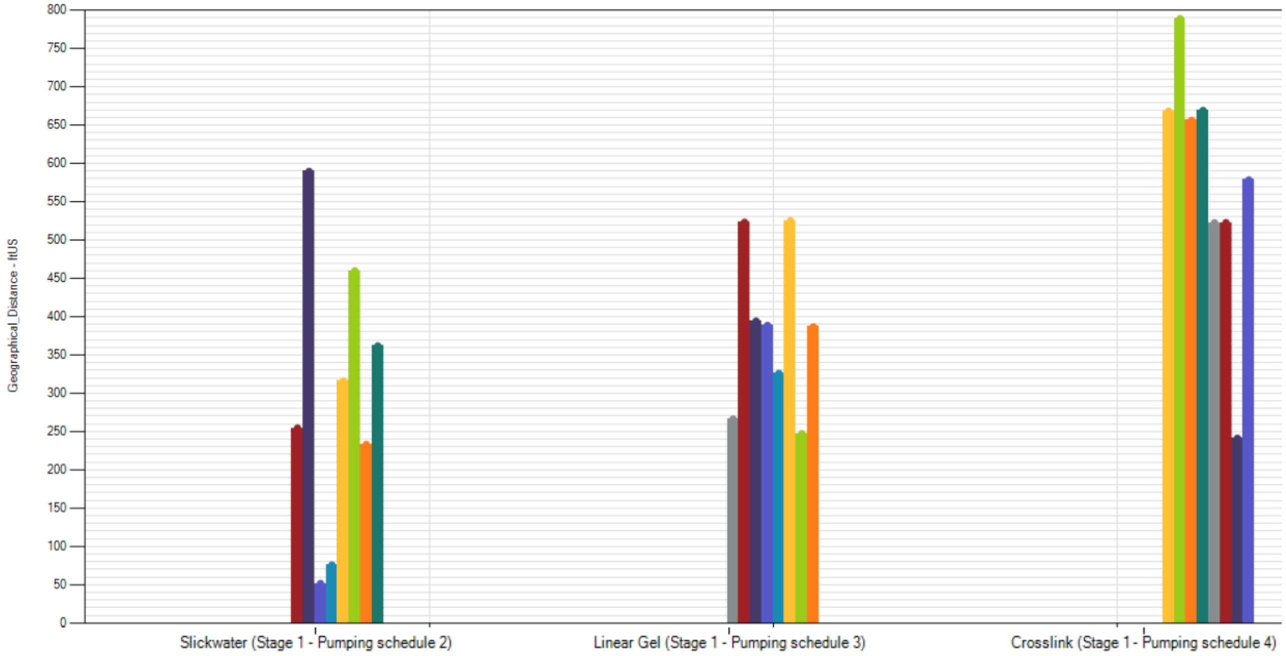
Results 2: Propped fracture surface areas



Results 3: Total fracture surface areas



Results 4: Fracture length distributions



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Conclusion

- Comparative study using three different fracturing fluids is used for hydraulic fracture design optimization.
- Results show that the use of cross-link gel leads to highest total and propped fracture surface areas, followed by linear gel and slickwater.
- Fractures generated by cross link gel, generally, have higher lengths compared to linear gel and slickwater.
- Fracture length distributions generated by linear gel and slickwater show similar distributions, with linear gel generated fracs exhibiting more uniform distribution
- As a future work, flow simulation of generated fracture networks using these fracking fluids can be done to compare dynamic flow responses of cases.

Thank You

Questions???